

Executive Summary

The City of San Diego (City) conducts extensive ocean monitoring to evaluate potential environmental effects from the discharge of treated wastewater to the Pacific Ocean via the South Bay Ocean Outfall (SBOO). The data collected are used to determine compliance with receiving water conditions as specified in the National Pollution Discharge Elimination System (NPDES) permits for the City's South Bay Water Reclamation Plant (SBWRP) and the International Wastewater Treatment Plant (IWTP) operated by the United States International Boundary and Water Commission (USIBWC). Since treated effluent from the SBWRP and IWTP commingle before being discharged to the ocean through the SBOO, a coordinated single monitoring and reporting program approved by the San Diego Regional Water Quality Control Board (RWQCB) and United States Environmental Protection Agency (USEPA) is conducted to comply with both permits.

The primary objectives of the ocean monitoring program for the South Bay outfall region are to: (a) measure compliance with NPDES permit requirements and California Ocean Plan (Ocean Plan) standards, (b) monitor changes in ocean conditions over space and time, and (c) assess any impacts of wastewater discharge or other man-made or natural influences on the local marine environment, including effects on water quality, sediment conditions and marine life. The monitoring region encompasses an area of approximately 345 km² (~133 mi²), which is centered around the SBOO discharge site located approximately 5.6 km offshore at a depth of 27 m. Shoreline monitoring extends from Coronado (San Diego) southward to Playa Blanca in northern Baja California (Mexico), while regular offshore monitoring occurs in adjacent waters overlying the continental shelf at depths of about 9 to 55 m.

Prior to the initiation of wastewater discharge in 1999, the City conducted a 3½ year baseline study designed to characterize and document background conditions in the South Bay outfall region.

Additionally, a larger-scale regional survey of benthic conditions is typically conducted each year at randomly selected sites ranging from northern San Diego County to the USA/Mexico border. These regional surveys are useful for evaluating patterns and trends over larger geographic areas, thus providing additional information to help distinguish possible reference areas from sites impacted by anthropogenic influences. The results of the 2010 regional survey off San Diego are presented herein.

The receiving waters monitoring activities for the South Bay outfall region are separated into several major components that are organized into nine chapters in this report. Chapter 1 presents a general introduction and overview of the ocean monitoring program, while chapters 2-7 discuss monitoring results for calendar year 2010. Specifically, in Chapter 2, data characterizing ambient physical and chemical oceanographic parameters and water mass transport for the South Bay outfall region are evaluated. Chapter 3 presents the results of water quality monitoring conducted along the shore and in local coastal waters, including measurements of fecal indicator bacteria (FIB) to determine compliance with Ocean Plan water contact standards. Assessments of benthic sediment quality and the status of soft-bottom macrobenthic invertebrate communities are presented in Chapters 4 and 5, respectively. Chapter 6 presents the results of trawling activities designed to monitor communities of bottom dwelling (demersal) fishes and megabenthic invertebrates. Bioaccumulation assessments to determine contaminant loads in the tissues of local fishes captured via trawls or by hook and line are presented in Chapter 7. Results of the summer 2010 San Diego regional survey of sediment conditions and benthic macrofaunal communities are presented in Chapters 8 and 9, respectively. In addition to the above activities, the City and USIBWC support other projects relevant to assessing the quality and movement of ocean waters in the region. One such project involves aerial and

satellite imaging of the San Diego/Tijuana coastal region, the results for 2010 which are incorporated into Chapters 2 and 3.

This report focuses on the results and conclusions of all ocean monitoring activities conducted in the South Bay outfall region from January 2010 through December 2010. An overview and summary of the main findings for each of the major program components are included below.

OCEANOGRAPHIC CONDITIONS

The South Bay outfall region was characterized by typical oceanographic conditions in 2010. This included seasonal patterns such as localized upwelling with corresponding phytoplankton blooms in the spring and summer, maximum stratification (layering) of the water column in late summer and early fall, and reduced stratification during the winter. Although some differences in salinity were observed near the discharge site, it was evident that any variation among stations was small and restricted to a highly localized area. Aerial imagery observations confirmed that the wastewater plume reached near-surface waters directly above the SBOO discharge site during the months of January, February, March and December when the water column was weakly stratified. In contrast, the plume remained deeply submerged between April and November when stratification was greater. Overall, ocean conditions during the year were consistent with patterns that have been well documented for southern California and northern Baja California. These findings suggest that natural factors such as upwelling of deep ocean waters and effects of widespread climatic events (e.g., El Niño/La Niña oscillations) continue to explain most of the temporal and spatial variability observed in the coastal waters off southern San Diego.

WATER QUALITY

There was no evidence that contaminated waters associated with wastewater discharge via the SBOO reached nearshore recreational waters off southern

San Diego in 2010. Although elevated FIB levels were detected in seawater samples collected along or near the shore during winter months, this contamination did not appear to be due to shoreward transport of the wastefield. Instead, the contamination was likely the result of heavy rainfall that increased outflows and the dispersion of associated turbidity plumes from the Tijuana River (USA) and Los Buenos Creek (Mexico). For example, 85% or more of all elevated FIBs recorded at the shore and kelp stations occurred during the wet season when rainfall was greatest. This general relationship between increased rainfall and high bacteria counts in local waters has remained consistent since monitoring began, including the 3–4 year period prior to wastewater discharge. The majority of elevated FIBs reported during the summer when rainfall was minimal occurred at shore stations located south of the international border and near known sources of contamination that are not associated with the SBOO. Most of the elevated FIB levels found close to the outfall were detected at a few nearfield sites located within 1000 m of the diffuser legs and at depths of 18 m or more.

Bacterial compliance levels were summarized as the number of days that each of the shore and kelp bed stations located in U.S. waters exceeded various Ocean Plan standards during each month. Due to regulatory changes that became effective August 1, 2010, compliance was assessed using the water contact standards specified in the 2001 Ocean Plan for samples collected from January 1 through July 31, 2010, whereas samples collected after August 1, 2010 were assessed using 2005 Ocean Plan standards. Bacterial compliance during the year was relatively high throughout the year with an overall compliance rate of 87% at these stations.

SEDIMENT CONDITIONS

The composition of benthic sediments sampled at the 27 regular (fixed-grid) South Bay outfall stations in 2010 varied from fine silts to very coarse sands or other relatively large particles (e.g., gravel, shells), and was similar to patterns seen in previous years. No apparent spatial relationship between sediment particle

size and proximity to the discharge site exists, nor has there been any substantial increase in fine sediments at nearfield stations or throughout the region since wastewater discharge began. Instead, the diversity of sediment types reflects multiple geological origins, or suggests complex patterns of transport and deposition from sources such as the Tijuana River and San Diego Bay.

Overall sediment quality at the South Bay outfall monitoring sites in 2010 was similar to previous years, and there was no evidence of contaminant accumulation associated with wastewater discharge. Concentrations of various trace metals, indicators of organic loading, pesticides (e.g., DDT), and PCBs varied widely throughout the region, with no patterns that could be attributed to the outfall or any other point sources. Instead, the accumulation of contaminants in sediments continued to be linked to natural environmental heterogeneity. For example, concentrations of organic loading indicators such as total organic carbon and total nitrogen, along with several metals, were typically higher at sites characterized by finer sediments, a pattern consistent with results from other studies. In addition, most contaminants detected in local sediments were within the range of predischARGE values reported for the region. Finally, the potential for environmental degradation by the contaminants detected during the year was evaluated using the effects-range low (ERL) and effects-range median (ERM) sediment quality guidelines when available. During 2010, there were no exceedances of the ERL or ERM thresholds.

MACROBENTHIC COMMUNITIES

Benthic macrofaunal assemblages surrounding the SBOO were similar in 2010 to those encountered during previous years, including the period prior to wastewater discharge. These assemblages were typical of those that occur in other sandy, shallow- and mid-depth habitats throughout the Southern California Bight (SCB). For example, most of the sandier, shallower sites contained high abundances of the spionid polychaete *Spiophanes norrisi*, a species characteristic of similar habitats and assemblages in

the SCB. In contrast, slightly different macrofaunal assemblages occurred at mid-depth stations that had finer sediments characteristic of much of the southern California mainland shelf.

Benthic community structure parameters such as species richness and total abundance varied with depth and sediment type, with no clear patterns relative to the SBOO discharge area. Instead, spatial patterns in macrofaunal abundance appear to be largely driven by changes in *S. norrisi* populations. The range of abundance values for macrobenthic invertebrates in 2010 was similar to that seen in previous years, and results for the benthic response index (BRI) were generally characteristic of reference conditions for the SCB. In addition, changes that did occur during the year were similar in magnitude to those that have occurred previously in southern California waters, and correspond to large-scale oceanographic processes or other natural events. Overall, macrofaunal assemblages in the region remain similar to those observed prior to wastewater discharge and to natural indigenous communities characteristic of similar habitats on the southern California continental shelf. There was no evidence that wastewater discharge has caused degradation of the marine benthos in the region.

DEMERSAL FISHES AND MEGABENTHIC INVERTEBRATES

Speckled sanddabs continued to dominate fish assemblages surrounding the SBOO in 2010 as they have in previous years. This species occurred at all stations and accounted for 49% of the total catch for the year. Other characteristic, but less abundant species included the California lizardfish, yellowchin sculpin, English sole, roughback sculpin, hornyhead turbot, California tonguefish, and longfin sanddab. Although the composition and structure of the fish assemblages varied among stations, these differences were mostly attributable to variation in speckled sanddab, California lizardfish, white croaker, yellowchin sculpin and English sole populations. Assemblages of relatively large (megabenthic), trawl-

caught invertebrates in the region were dominated by the shrimp *Crangon nigromaculata* and the sea star *Astropecten verrilli*. Variations in megabenthic community structure generally reflect changes in the abundance of these two species, as well as other common invertebrates such as the sand dollar *Dendraster terminalis*, the crab *Portunus xantusii*, the brittle stars *Ophiothrix spiculata* and *Ophiura luetkeni*, the shrimp *Sicyonia ingentis*, and the squid *Doryteuthis opalescence*.

Overall, results of the 2010 trawl surveys indicated that demersal fish and megabenthic invertebrate communities in the region were unaffected by wastewater discharge. The relatively low species richness and small populations of both fish and mega-invertebrates are consistent with the shallow, sandy habitat that was surveyed. Patterns in the abundance and distribution of species were similar at stations located near the outfall and farther away, suggesting a lack of significant anthropogenic influence. Additionally, the examination of each fish for evidence of disease (e.g., tumors, fin erosion, skin lesions) or ectoparasites indicated that local fish populations remain healthy. For example, external parasites and other external abnormalities occurred in less than 0.1% of the fish collected in the South Bay outfall region during 2010. These results were consistent with findings from previous years.

CONTAMINANTS IN FISH TISSUES

The accumulation of contaminants in marine fishes may be due to direct exposure to contaminated water or sediments or to the ingestion of contaminated prey. Consequently, the bioaccumulation of chemical contaminants in local fishes was assessed by analyzing liver tissues from trawl-caught fishes and muscle tissues from species captured by hook and line. Results from both the liver and muscle tissue analyses indicated no evidence to suggest that contaminant loads in fishes captured in the South Bay outfall region were affected by wastewater discharge in 2010. Although several tissue samples contained metals that exceeded pre-discharge maximums, concentrations of most contaminants were generally similar to that observed

prior to discharge. In addition, tissue samples that did exceed pre-discharge contaminant levels were collected from fishes that were widely distributed throughout the region and showed no pattern relative to the discharge site. Furthermore, all tissue contaminant concentrations were within the range of values reported previously for southern California fishes.

The occurrence of both metals and chlorinated hydrocarbons in fishes living around the South Bay outfall may be due to many factors, including the ubiquitous distribution of many contaminants in southern California coastal sediments. Other factors that affect the bioaccumulation and distribution of contaminants in local fishes include the different physiologies and life history traits of various species. Additionally, exposure to contaminants can vary greatly between species of fish and even among individuals of the same species depending on migration habits. For example, a fish may be exposed to contaminants in a polluted area and then migrate to a region that is less contaminated. This is of particular concern for fishes collected in the vicinity of the SBOO, as there are many other point and non-point sources that may contribute to contamination.

SAN DIEGO REGIONAL SURVEY

The summer 2010 San Diego regional benthic survey covered an area ranging from offshore of Del Mar south to the USA/Mexico border. A total of 40 new, randomly selected sites were sampled at depths ranging from 9 to 433 m, and spanned four distinct depth strata as characterized by the SCB Regional Monitoring Programs (i.e., inner shelf, mid-shelf, outer shelf, upper slope).

Regional Sediments

Particle size composition of sediments at the regional stations sampled in 2010 was typical for continental shelf and upper slope benthic habitats off southern California, and consistent with results from previous surveys. These sediments consisted mainly of sands, with the percentage of silt and clay (percent fines) increasing with depth. However,

several exceptions to this general pattern occurred throughout the region, particularly at outer shelf sites along the Coronado Bank, a southern rocky ridge located southwest of Point Loma at depths of 150–170 m. Sediment composition in this area is generally coarser than stations located at similar depths west of Point Loma and further to the north.

As with particle size distributions, regional patterns of sediment contamination were similar in 2010 to those observed in previous years. For example, concentrations of total nitrogen and several trace metals were found to increase with increasing percent fines. Since the percentage of these fine sediments typically increases with depth, many contaminants were detected at higher concentrations in deeper strata compared to the inner and mid-shelf areas. For example, the highest concentrations of most contaminants were found along the upper slope where some of the finest sediments were measured.

Overall, there was no evidence of widespread degradation of sediment quality at the stations surveyed during the July 2010 regional survey. ERL threshold values were exceeded in only one sample for lead (station 8023), one sample for nickel (station 8037), and two samples for DDT (stations 8012 and 8028). The total DDT measured in the sample from station 8028 was also the only exceedance of the ERM threshold at the regional sites.

Regional Macrofauna

The SCB benthos has long been considered to be composed of heterogeneous or “patchy” habitats, with the distribution of species and communities exhibiting considerable spatial variability. Results of the summer 2010 regional survey off San Diego generally support this characterization. Benthic macrofaunal assemblages in the region appeared to segregate primarily by habitat characteristics such as depth (i.e., strata) and sediment grain size, and were similar to assemblages observed during previous years.

About one-third of the benthos sampled off San Diego in 2010 was characterized by mixed sediment

(~41% fines) assemblages that occurred along the mid- to outer shelf at depths of 50–123 m. These assemblages were dominated by the brittle star *Amphiodia urtica*, and correspond to the *Amphiodia* “mega-community” described previously off southern California. Deeper assemblages devoid of *A. urtica* and that were dominated instead by polychaetes (e.g., *Aphelocheata glandaria*, *Monticellina siblina*, and *Chaetozone* sp SD5) occurred at outer shelf depths between 125–161 m where sediments were relatively coarse (~22% fines). Several nearshore assemblages were also present that are similar to those found in other shallow, sandy habitats in the SCB and as described above for the regular SBOO fixed-grid survey monitoring area. The upper slope and deepest outer shelf habitats surveyed during the year were characterized by higher percentages of fine sediments (averaging ~64–71% fines) than found at shallower shelf sites. For example, macrofaunal assemblages from the five upper slope stations that occurred at depths <320 m clustered with those from the two deepest outer shelf stations. This shelf-slope transition assemblage lacked high abundances of *A. urtica*, but was instead dominated by polychaetes such as *Spiophanes kimbali*, *Mediomastus* sp, and *Maldane sarsi*. In contrast, macrofaunal assemblages present at the two deepest upper slope stations (depths >420 m) where sediments averaged 71% fines comprised their own separate clade. This group was distinguished by considerably fewer species and lower abundances than elsewhere, and was represented by *M. sarsi* and the bivalve *Yoldiella nana* as the most characteristic species

Although benthic communities off San Diego vary across depth and sediment gradients, there was no evidence of disturbance during the 2010 regional survey that could be attributed to wastewater discharges, disposal sites or other point sources. Benthic macrofauna appear to be in good condition throughout the region, with 92% of the sites surveyed being classified in reference condition based on assessments using the benthic response index (BRI). This pattern is consistent with recent findings for the entire SCB mainland shelf.

CONCLUSIONS

The findings and conclusions for the ocean monitoring efforts conducted for the South Bay outfall region during calendar year 2010, as well as the summer 2010 San Diego regional benthic survey, were consistent with previous years. Overall, there were limited impacts to local receiving waters, benthic sediments, and marine invertebrate and fish communities. There was no evidence that the wastefield from the outfall reached recreational waters during the year. Although elevated bacterial levels did occur in nearshore areas, such instances were largely

associated with rainfall and associated runoff during the wet season and not to shoreward transport of the wastewater plume. There were also no outfall related patterns in sediment contaminant distributions, or in differences between the various macrobenthic invertebrate and fish assemblages. The general lack of disease symptoms in local fish populations, as well as the low level of contaminants detected in fish tissues, was also indicative of a healthy marine environment. Finally, results of the regional benthic survey conducted during the year also revealed no outfall related effects, and that benthic habitats in the region remain in good condition similar to much of the southern California continental shelf.